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ABSTRACT

The effects of varied lighting and coloring in the classroom environment were examined on the behavior of seven severely handicapped 8 to 11 year olds with behavior problems. Analysis of changes in systolic blood pressure indicated that Ss were more comfortable and relaxed in the experimental room (in which the fluorescent lights were replaced by lights simulating sunshine in the visible and ultraviolet spectrum). Blind Ss were as affected as sighted Ss. Aggressive and nonattentive behaviors appeared more frequently in the afternoon than the morning, while destructive behavior was more likely to occur in the morning. (CL)

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EFFECTS OF COLOUR/LIGHT CHANGES ON SEVERELY HANDICAPPED CHILDREN

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The Effect of Colour Psychodynamic Environment on the Psychophysiological and Behavioural Reactions of Severely Handicapped Children

by

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and

C. Sam

Under Contract to

Alberta Education

October 1981

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FOREWORD

An opportunity for a quick study of optimum classroom conditions with respect to colour and lighting took place in the spring of 1981 at Elves Memorial Child Development Centre, an Edmonton private school for severely handicapped children.

Could environmental intervention have an impact physiologically and behaviourally? If so, consideration could be given to its use in replacing or supplementing other strategies to enhance classroom functioning.

The results, interesting and provocative, strongly suggest the potential merit of further research in this area.

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PART 1

PURPOSES, PROCEDURES, STUDY DESIGN

Purposes

Elves Memorial Child Development Centre, a private school funded by grants from Alberta Education, provides developmental day programs for dependent handicapped students from Edmonton and vicinity.

There are many challenges for teaching staff working with these multiply handicapped students. It is not unusual for the classroom situation to be further complicated by behavioural disturbances. Unprovoked aggression, tantrums, various manifestations of short attention span, and self abuse, are typical examples of problem behaviour.

These behaviours may result in special behaviour modification programs being instituted, may jeopardize the child's school placement if there is repeated injury to others, may lead to the use of medication for control, may result in the use of restraint procedures, and will always inhibit the learning process for the child concerned and for others in the room. The fatigue of staff is also a concern.

At Elves Memorial Child Development Centre, it is always the preference to use the least invasive remedial techniques whenever possible - those that impose minimal stress on the classroom staff and the students.

This study attempted to measure the impact behaviourally and physiologically of relatively simple modifications to colour and lighting in an existing classroom.

Study Design and Procedures

Elves Memorial Child Development Centre, located in Edmonton at 10825 - 142 St., is well designed for study purposes. Observation rooms with sound systems look into each classroom through one way glass. The room selected for this study had seven students and two full-time staff members.

This classroom was understood by all staff in the school to be a very difficult grouping with which to work - it had acquired some notoriety due to the amount and severity of problem behaviours encountered on any given day. The teachers were admired but not envied.

For the study a cross over design was employed.

Observation involved the unobtrusive use of video-tape recording, from the observation room. Two fifteen minute segments per day were filmed, one mid-morning, the other near the end of the classroom day. These were later used to count behaviours.

The video tapes were viewed and behaviours were counted by a research assistant hired specifically for this task. She had not done the taping and did not know the students. The tapes were randomly selected and were viewed away from the school. The research assistant was aware of which phase she was scoring at any given time.

For the purpose of counting the behaviours four categories were identified and defined as follows:

	Where instance counts as 1.	
Aggressive Behaviour	- biting	inflicted on another
	- striking	person in the classroom
	- scratching	

- pulling hair
- pinching

Destructive Behaviour	- ripping - tearing - throwing	materials in use in the classroom
Self Abusing Behaviour	- biting - striking - scratching - pulling hair - pinching	inflicted on self
Non Attentive	- student leaves group activity - does not attend to task - ignores teacher - engages in self stimulatory activity	

The behaviours were counted by category for the whole class in each segment viewed. They were not counted per child.

To ensure consistency, there were inter-observer and intra-observer reliability checks. The percentage agreement was high with scores of:

85.8% Inter-observer over six samples

and 96.4% Intra-observer over eight samples

Sample = One behaviour category scored in one 15 minute video segment.

(See Appendix I)

Problems were encountered in operationalizing and counting non-attentive behaviours. Had time and resources permitted, data from this category would have been re-worked. We have more confidence in the data from the other categories.

Blood pressure and pulse readings, assumed for this study to be proxy indicators of stress, were taken three times per day. The research assistant hired to measure blood pressure and pulse was a person highly skilled in child care, known to the students and familiar with them. It was hoped that with her introducing the new procedure, distress and discomfort would be minimized and readings would be more accurate. Data was subjected to computer analysis.

Observation Schedule

Blood Pressure and Pulse	8:50 - 9:15	a.m.
Video-Tape Recording	10:15	
Blood Pressure and Pulse	10:30	
Video-Tape Recording	2:00	p.m.
Blood Pressure and Pulse	2:15	

Data collecting was to be completed by the end of May; June was not seen as a typical classroom month with year end approaching.

Phase I - baseline conditions March 16-27 (10 school days)

- cool white fluorescent lighting, diffuser panels in place
- bright orange carpet over 4/5 of floor
- rust brown tile on 1/5 of floor

- one long wall solid orange vinyl
- other walls off white, painted
- dark trim around doors and windows
- bright yellow storage cupboards
- bright yellow shelving
- bright yellow bulletin board
- chairs neutral grey
- tables - one blue, 2 peach
- 1 orange screen

During the school holiday week of spring break the classroom was redecorated.

Room temperature and paint odor were not considered. No attempt was made to replace wall decorations removed at each redecorating. (See Appendix II)

Phase II April 6 - 24 (13 school days)

- full spectrum fluorescent lighting - diffuser panels removed
- light warm grey carpeting 4/5 of floor
- rust brown tile 1/5 of floor
- long orange wall was painted a medium tone royal blue
- the white walls were painted a light warm blue
- window and door frames were painted medium tone royal blue
- shelving, bulletin boards, storage cupboards were painted medium tone royal blue
- furnishings remained the same
- orange screen was removed

See colour samples and Munsell coordinates, Page 9 .

Phase III April 27 - May 15 (15 school days)

- the room was returned to original Phase I baseline conditions, redecorated over a weekend.

Transported either by their parents or Edmonton Handibus Association school buses, the children in this study arrived at school between 8:50 a.m. and 9:15 a.m. Toileting, the first blood pressure and pulse reading, personal care routines, supervision, took place during the period up to 9:30 a.m. The classroom program then ran for the next five hours, from 9:30 a.m. to 2:30 p.m. There were neither noon hour breaks nor recess breaks for the students, as meal time is a major instruction opportunity, and even free play must be well supervised for children this severely handicapped.

The students studied were not confined to the test classroom. Their normal schedule was maintained and they continued to use all the usual activity areas available at the school: wading pool, large indoor central play area, outdoor playground.

Although it was not part of the original study plan, early in Phase I a spontaneous decision was made to take blood pressure and pulse readings on the teaching staff. Those results will also be included in this report.

When the new school year started Subjects #1 to #5 originally studied were still in attendance at Elves Memorial Child Development Centre. Subjects #6 and #7 had moved on to other school settings. Administrative decisions were made to disperse the five remaining students, given the difficulties with management of the class in the previous year. From September the five have been served in three different classrooms. None are with their previous teacher and none are in last year's room. The three rooms now in use have design schemes similar to Phase I of this study.

In October, for a period of one school week (five days) blood pressure readings were taken on the five students. The results of this follow up week of measurements will be presented although this too was not part of the original proposal.

Characteristics of Students

	Date of Birth	Sex	Diagnosis
1*	28/10/70	M	Severe mental retardation Severe behaviour disorder Severe language delay
2	14/03/73	F	Left hemiparesis Congenital parencephalic cyst with ventrical shunt Severe mental retardation Hearing loss Epilepsy Severe language delay
3	30/06/72	M	Blind Severe mental retardation Severe behaviour disturbance Suspected hearing loss Severe language delay
4*	16/05/70	M	Blind Severe psychomotor retardation Severe behaviour disorder
5	31/10/70	M	Downs syndrome Severe mental retardation General hypotonia Behaviour disorder Severe language delay
6*	17/04/72	M	Severe mental retardation Severe behaviour disturbance Severe language delay
7	16/03/73	M	Severe convulsive disorder Severe mental retardation Suspected hearing loss Severe language delay

* sometimes also described as hyperactive.

Colour and Light Selection

Until the early 1950's theories regarding the effect of colour upon people were largely based on speculation, introspection and often, just wild guesswork. Dr. Max Luescher of Switzerland was the first person to use phenomenological reasoning and concepts to put his psychology of colour on a sound and systematic footing (1952). In 1955 - 58, H. Wohlfarth set out to either prove or disprove that colour has a measura le and predictable effect upon people by using the autonomic nervous system (blood pressure, pulse and respiration rate) as a reaction indicator in his empiric research.

The result was the following thesis of colourpsychodynamics: blood pressure, pulse and respiration rates increase in the following sequence - red, minimum; orange, medium; yellow, maximum. The sequence of decrease is green, minimum; blue, medium, black, maximum.

Consequently, the work of Luescher and Wohlfarth laid the foundations for the modern science of colourpsychodynamics. T. Pellegrini and A. Schauss (U.S.A.) contributed recently by investigating the effect of colour upon the endocrine system.

The design scheme tested at Elves Memorial Child Development Centre was one thought to have potential in quieting autonomic and behavioural response.

During Phase II the cool white fluorescent bulbs lighting the room were replaced by Vita-Lites (with powertwist) from Duro-Test Corporation. This is a full spectrum general purpose fluorescent light, simulating sunshine in the visible and ultraviolet spectrum. Colour Rendering Index was one reason for its selection. The Vita Lite providing a C.R.I. of 91 compared to 68 in cool white.

The growing interest in and work on the possible health value of full spectrum lighting alsc influenced its selection. As with colour, the intent was to modify the classroom physical environment, seeking optimum conditions by selecting colours and lighting thought to be quieting physiologically and behaviourally.

ROCM 2 COLOURS, PHASES I and III

4684-2
Blackstone

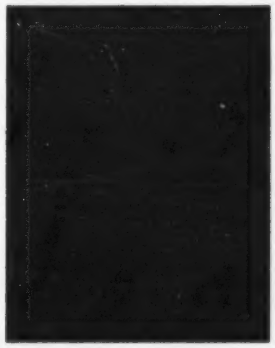
4657-5
Josephine

3117-5
Fantasy Yellow

4588-7
Twinkle

ROOM 2 COLOURS, PHASES II

4717-9
Mountain Ash
(approximate carpet colour)



3941-9
Columbia Blue

3939-8
Opera Blue

All colours are BAPCO paint.

Munsell Coordinates.

Limitations

- Light and colour were not separated in this study - clarification could be obtained by further research. (Currently part of a research design to be carried out in schools in Wetaskiwin Alberta, 1982 - 3).
- Specific colours and lighting were used.
- A very specific group of children were subjects of the study. Although the results may be of interest, the restricted focus limits their application.
- The teaching staff and the research assistants were not kept "blind" with respect to expected outcomes.
- The study phases were short - the schedule compressed. A quick study, but intended to point towards further work in the area.
- The possibility of a "Hawthorne" effect (The Hawthorne experiments conducted at the Hawthorne Plant of Western Electric by Professor E. Mayo, Harvard Graduate School of Business in the late 1920's. Reported in detail in F.J. Roethlisberger and W.J. Dickson Management and the Worker, Harvard, Cambridge, Mass., 1966.) cannot be overlooked, with respect to the involvement of the research assistant taking blood pressure and pulse readings.

PART 2

RESULTS

TABLE 1

BEHAVIOURDYNAMIC REACTIONS:

COMPARISON OF AVERAGES IN PHASES I II III

Full day behaviour counts were added per category then divided by days to arrive at these summary figures.

Full Day Averages

	Aggression	Destruction	Self Abuse	Non-Attentive
Phase I	12.00	3.00	10.50	66.20
Phase II	6.00	3.00	8.20	19.60
Phase III	7.50	2.50	4.50	11.75

Morning behaviour counts were added then divided by number of days for this summary.

Mornings Only

	Aggression	Destruction	Self Abuse	Non-Attentive
Phase I	4.25	2.25	5.75	28.75
Phase II	2.00	2.25	4.75	8.50
Phase III	2.25	2.50	1.75	5.00

Afternoon behaviour counts were added then divided by days for this summary.

Afternoons Only

	Aggression	Destruction	Self Abuse	Non-Attentive
Phase I	7.75	0.75	4.75	31.50
Phase II	4.00	0.75	3.50	11.20
Phase III	5.25	0.00	2.75	6.75

(See Appendix III for samples of daily detail sheets).

Full Day Averages

Looking at the full day averages, aggression, self abuse and non-attentive behaviour can be seen to drop markedly from Phase I to Phase II; destruction remains constant. In Phase III aggressions begin to increase again; the scores for destruction, self abuse and non-attentive behaviour continue to decrease.

Although a rapid increase up to Phase I scores was not expected in Phase III, neither was a continued drop. This puzzling phenomenon brings to mind the recent work of Pellegrini and Schauss. Testing the effect of "Becker-Miller-Pink" rooms on violent behaviour, they found that an exposure of 15 minutes resulted in a continuing after effect of 30 minutes duration. Perhaps the Phase III results represent a carry over from Phase II. Clearly, more work is needed here. A much longer Phase III might have yielded interesting data.

The scores for the aggressive behaviour category fit best with outcomes expected in all Phases.

Morning and Afternoon Averages

Comparing morning to afternoon counts, aggressive and non-attentive behaviours appear higher in the afternoon in all phases. Destructive behaviour is lower in all Phases in the afternoon and appears much more likely to occur in the morning period. Self abuse is higher in the mornings in Phases I and II, but low in the morning in Phase III.

This information may be useful to classroom staff with respect to the scheduling of their activities. Again, it suggests possibilities for future study.

Psychophysiological Reactions

As there were two blind students in the room and as the teachers

were also measured, the blood pressure and pulse results are tabulated for all subjects in the room and also for these three categories: seeing children, blind children, teachers.

TABLE 2

PSYCHOPHYSIOLOGICAL REACTIONS:

COMPARISON OF AVERAGES, PHASES I II III

All Subjects in the Room

	Blood Pressure	Pulse	Time Frame
Phase I	117/65	91	a.m.
	124/69	96	noon
	121/67	97	p.m.
Phase II	104/65	91	a.m.
	104/67	92	noon
	104/65	93	p.m.
Phase III	103/66	84	a.m.
	107/69	87	noon
	105/68	88	p.m.

Seeing Children

	Blood Pressure	Pulse	Time Frame
Phase I	117/64	92	a.m.
	123/68	98	noon
	119/64	100	p.m.
Phase II	99/62	94	a.m.
	101/65	95	noon
	101/62	96	p.m.
Phase III	98/63	85	a.m.
	102/67	89	noon
	101/65	90	p.m.

Blind Children

	Blood Pressure	Pulse	Time Frame
Phase I	118/65	94	a.m.
	125/66	100	noon
	121/70	98	p.m.
Phase II	101/64	92	a.m.
	99/65	95	noon
	99/62	94	p.m.
Phase III	99/65	87	a.m.
	102/67	91	noon
	97/65	89	p.m.

Teachers

	Blood Pressure	Pulse	Time Frame
Phase I	117/72	82	a.m.
	124/75	82	noon
	124/74	89	p.m.
Phase II	119/74	84	a.m.
	117/73	82	noon
	118/72	86	p.m.
Phase III	120/76	80	a.m.
	123/76	80	noon
	122/77	83	p.m.

TABLE 3

PSYCHOPHYSIOLOGICAL REACTIONS:

COMPARISON OF AVERAGES BY SUBJECT CATEGORY, PHASES I II III

Systolic Blood Pressure Means

	Seeing Children	Blind Children	Teachers
Phase I	120	121	122
Phase II	100	100	118
Phase III	101	100	122

Diastolic Blood Pressure Means

	Seeing Children	Blind Children	Teachers
Phase I	65	67	74
Phase II	63	64	73
Phase III	65	66	76

Pulse Means

	Seeing Children	Blind Children	Teachers
Phase I	96	97	85
Phase II	95	94	84
Phase III	88	89	81

In Phase I we see blood pressure and pulse rising during the day. The first readings of the day being the lowest, blood pressure highest at noon, pulse highest in the afternoon.

In Phase II, blood pressure is lower and stable for all three readings. Pulse rises slightly but not as high as in Phase I.

In Phase III, blood pressure begins to rise during the day,with the same pattern emerging as in Phase I (first reading lowest, noon reading highest, last reading higher than a.m. reading), pulse rises during the day.

As with the behavioural reactions, there was no rapid return to Phase I measures,although indication of a return does begin to take place.

The two blind children (subjects 3 and 4) showed the same basic pattern of systolic blood pressure reaction. Since only part of this can be explained by their reaction to the other children, a hypothesis on this phenomenon is presented in the final summary. It is intended by H. Wohlfarth in cooperation with Dr. P. Flor-Henry of the Alberta Hospital, Oliver, to do further research into this phenomenon in a future project.

The differential between the Phases is statistically significant. (See Appendix IV)

An important drop of 20 points was seen in the systolic blood pressure readings of the classroom students, during Phase II. Systolic blood pressure is responsive to environmental impact: up in stressful situations, down in a quiet relaxed atmosphere.

No great change was expected in the diastolic pressure - the small change that was seen may in fact be significant.

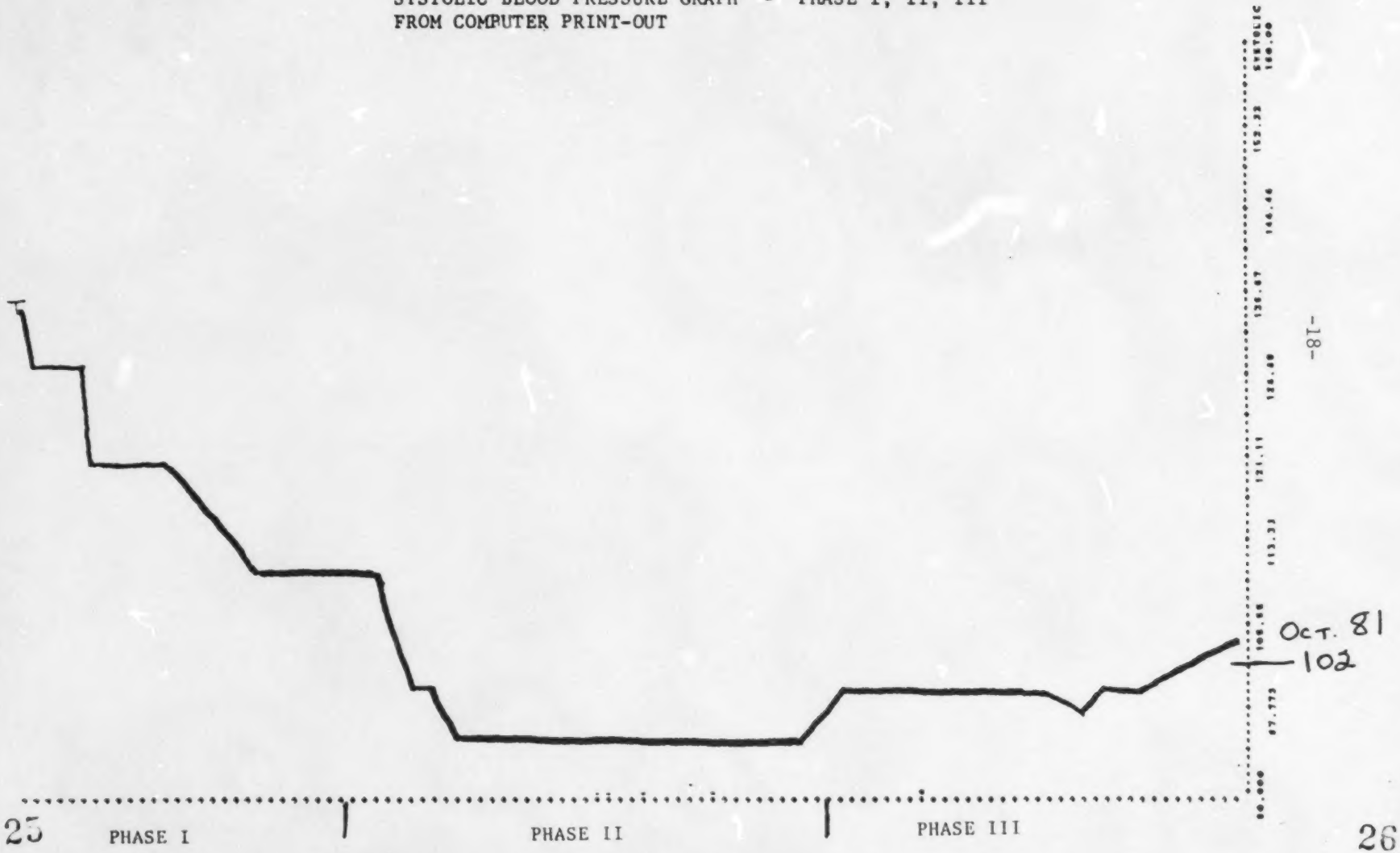
The fact that there was little change in the teacher's blood pressure may reflect the fact that they felt under pressure from the experiment itself.

TABLE 4

TIME SERIES PLOTS OF SYSTOLIC BLOOD PRESSURE BY SUBJECT

These graphs present a very interesting picture. A generally declining blood pressure is seen in Phase I. The lowest and most stable readings occur in Phase II. In Phase III the readings can clearly be seen to begin climbing again.

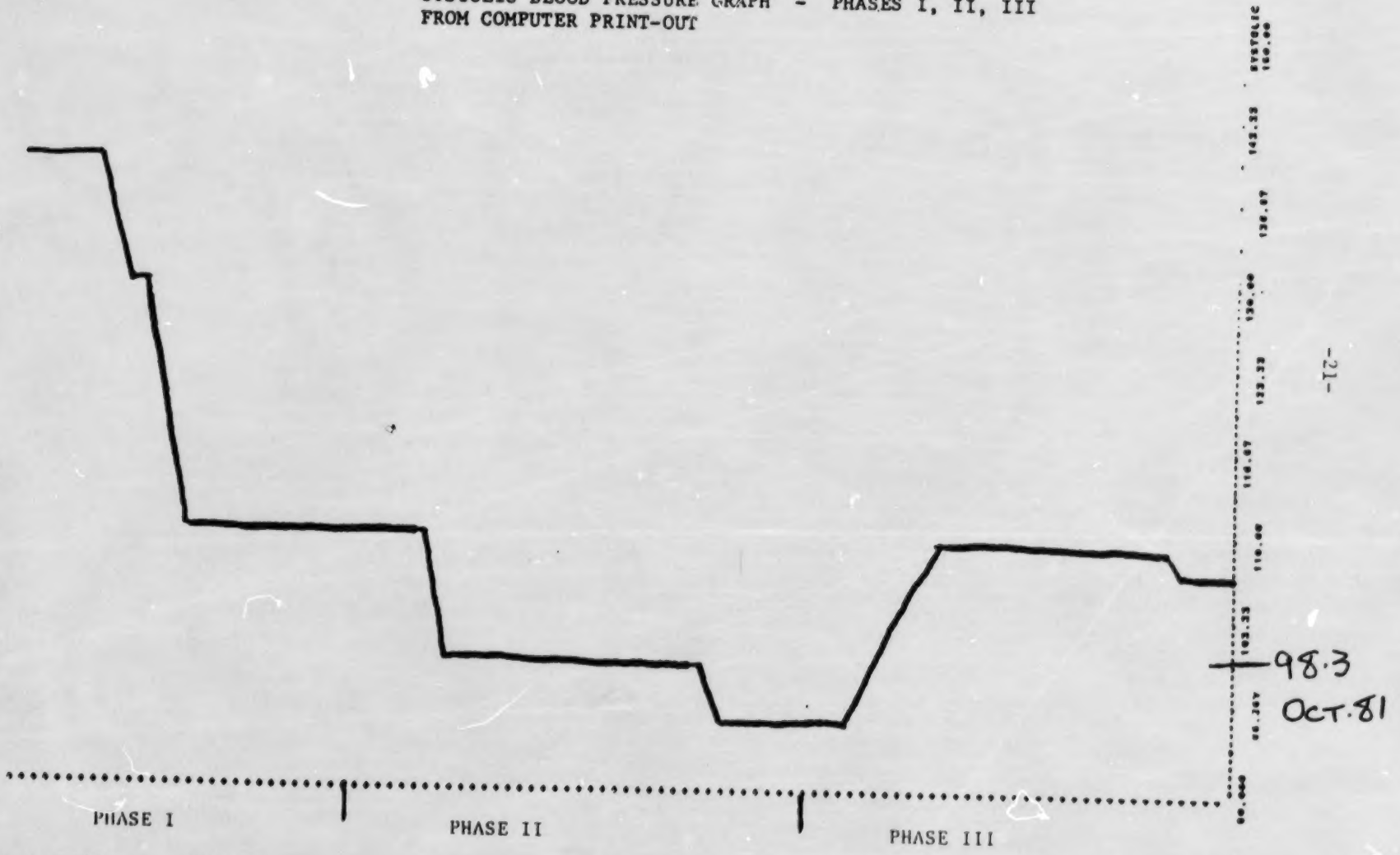
SUBJECT 1
SYSTOLIC BLOOD PRESSURE GRAPH - PHASE I, II, III
FROM COMPUTER PRINT-OUT



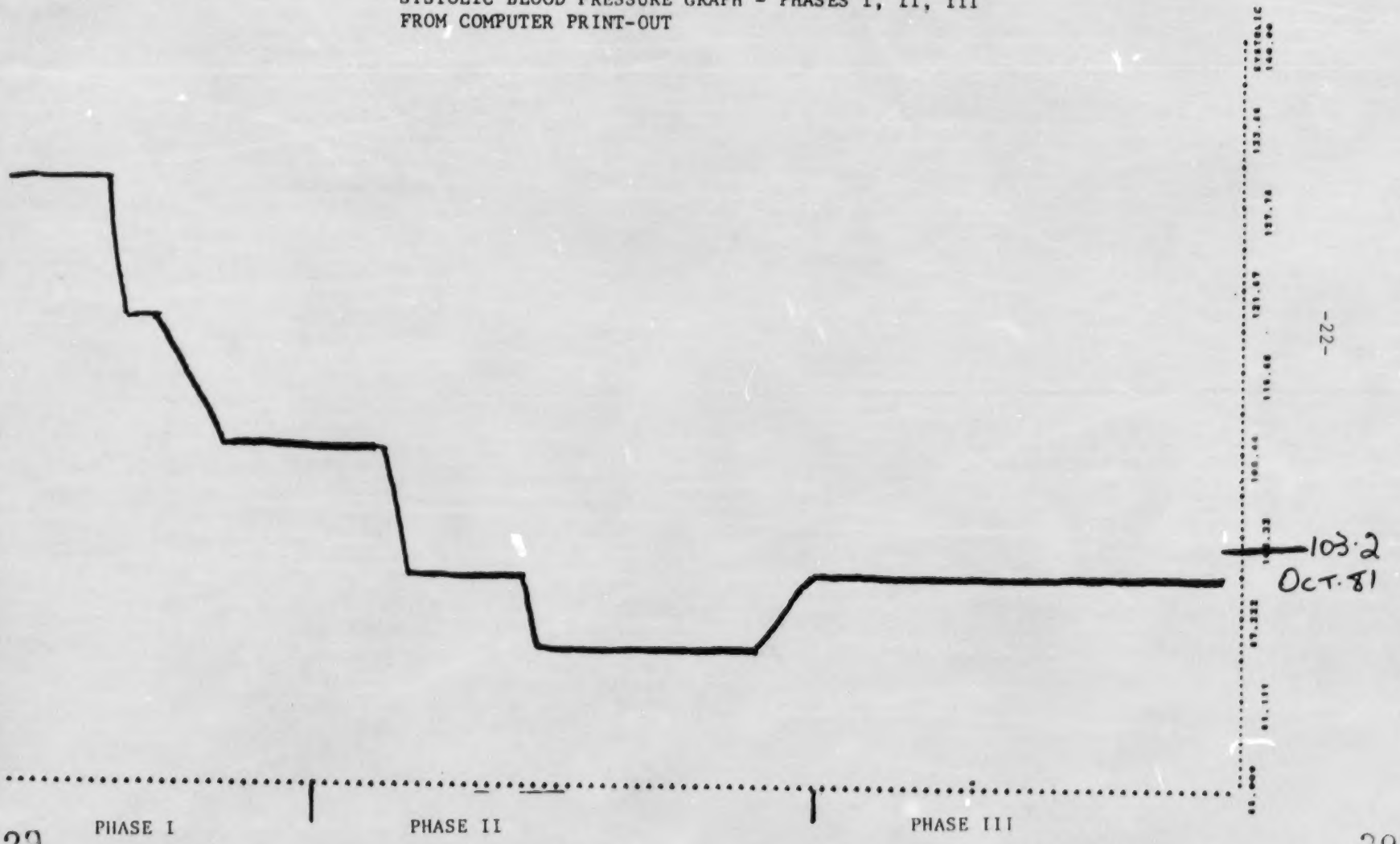
25

26

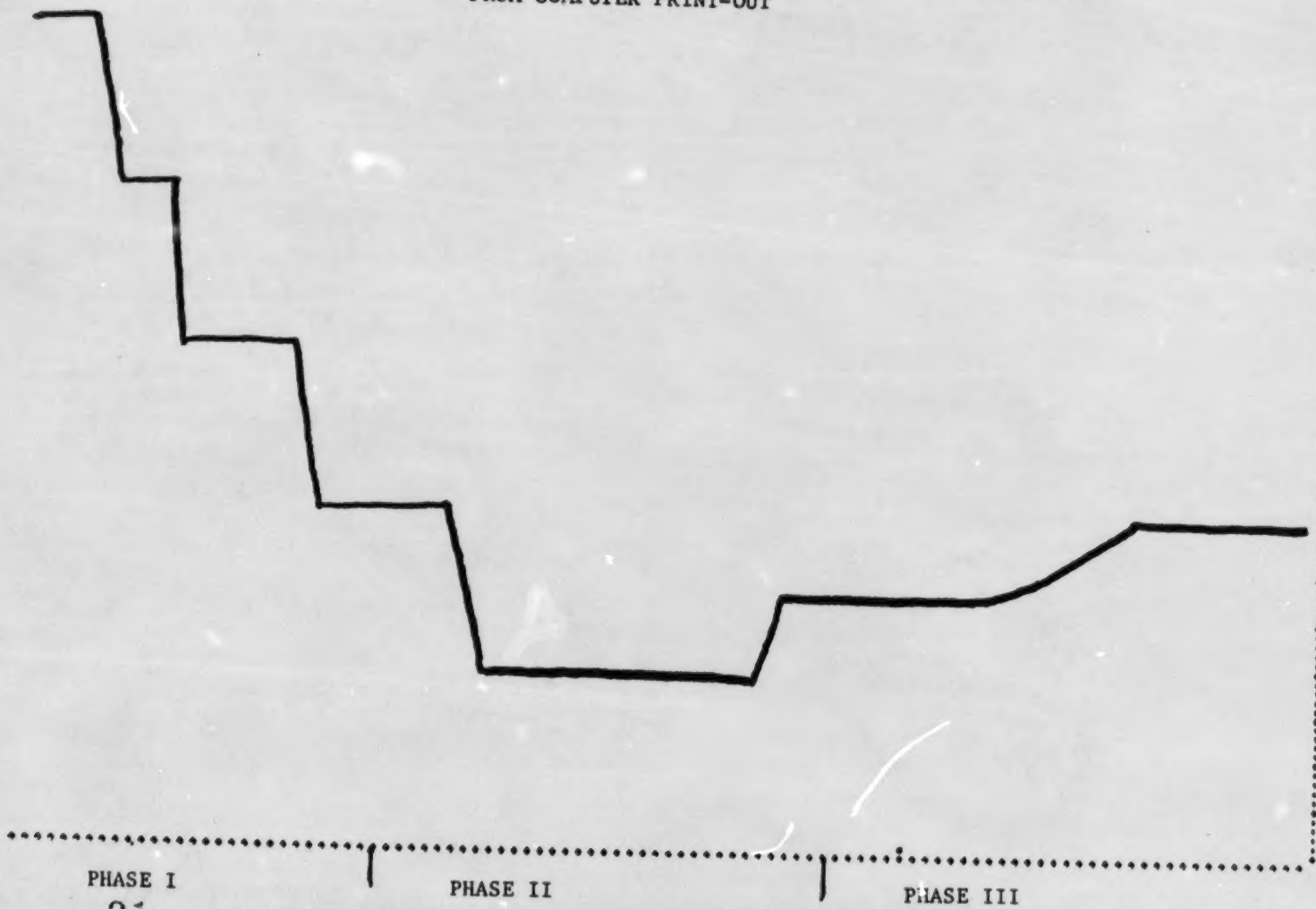
SUBJECT 4
SYSTOLIC BLOOD PRESSURE GRAPH - PHASES I, II, III
FROM COMPUTER PRINT-OUT



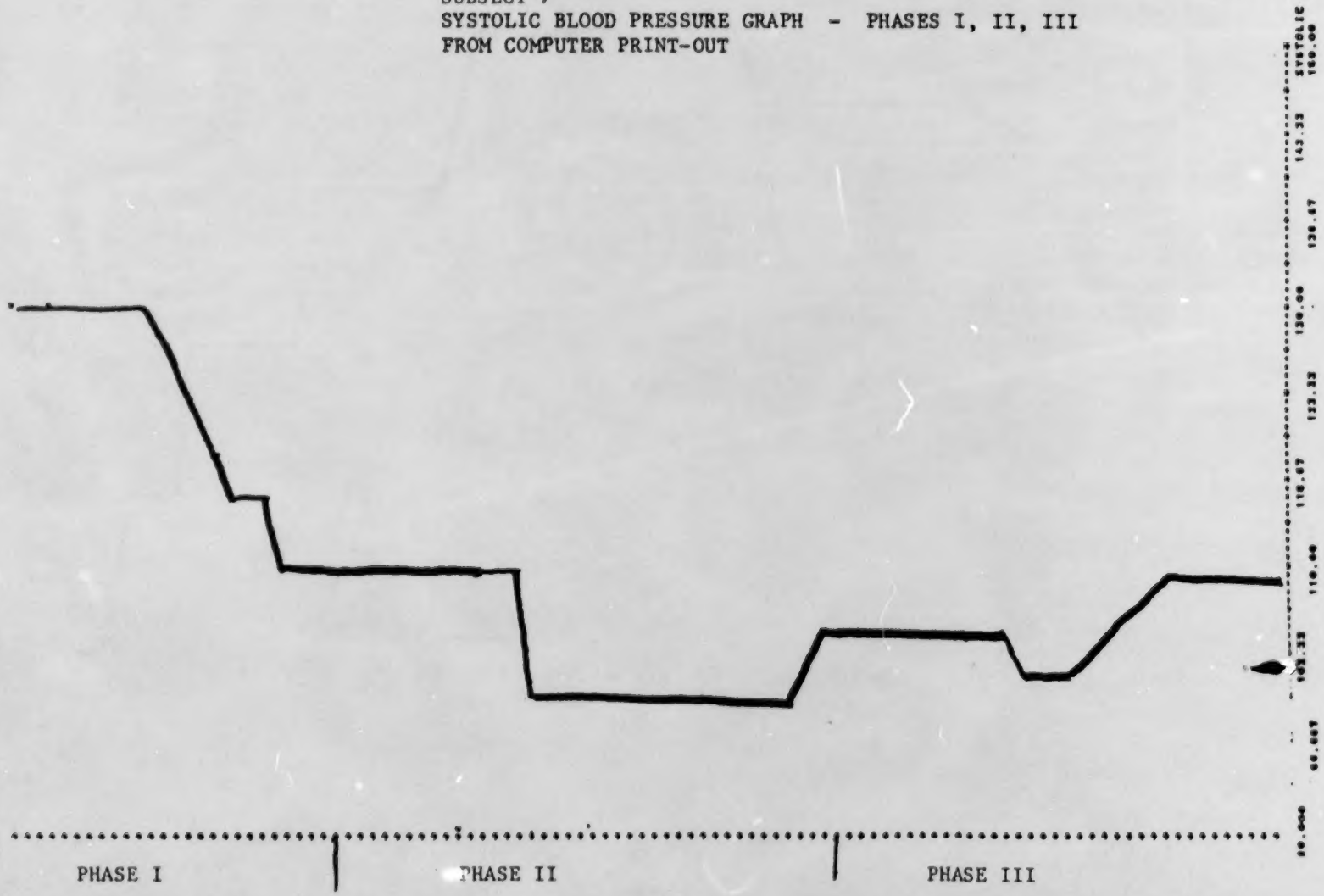
SUBJECT 5
SYSTOLIC BLOOD PRESSURE GRAPH - PHASES I, II, III
FROM COMPUTER PRINT-OUT



SUBJECT 6
SYSTOLIC BLOOD PRESSURE GRAPH - PHASES I, II, III
FROM COMPUTER PRINT-OUT



SUBJECT 7
SYSTOLIC BLOOD PRESSURE GRAPH - PHASES I, II, III
FROM COMPUTER PRINT-OUT



Nurses Comments

Some comments by the nurse consultant made during Phase II upon considering the data:

Whereas.....the readings in the old room are slightly hypertensive for a child in this age group, the present readings in the experimental room are normotensive. We may infer that the children are more comfortable and more relaxed. We find this especially interesting as these children are typically more agitated after a break (week of spring break at home, during which the classroom was redecorated). The blood pressure is the more significant reading due to the variability of pulse rates in general. Also, pulses were only taken for 10 seconds.

Our research assistant, while taking vital signs, has noted with each measure if the child was quiet or distressed. When distressed, we noted a significant jump in blood pressure and pulse. However, since the experimental situation (light and Colour), we note that even when distressed, the readings don't climb as high as previously.

Also - in general, there is less distress. One child has a lower reading now when distressed than he had when quiet during the previous data collecting.

Before, we saw children's readings increase during the day - the lowest reading being the first reading of the day (whether distressed or unaccepting) now, their highest readings are the first in the day, and the readings become lower during the day.

Teachers Comments

Two weeks after all data were in, the classroom staff were asked to write very subjectively and very conversationally about their experience in each of the Phases. How did it feel for them? What was it

like from their perspective? Their notes make interesting reading.

Comments by the Two Classroom Teachers, Chris and Sue (Phase I):

Chris

When I first heard about the experiment, I have to honestly say that I felt skeptical. I found it hard to believe that colours could have such a strong impact. At the same time, I also felt curious and excited that our room was chosen.

At first, I felt very nervous about being video taped. I have never been video taped before and just the idea made me feel uncomfortable! It helped to have the machine in the observation room. I knew it was there but I didn't have to see it. Also, at first, I felt embarrassed to have my blood pressure and pulse taken.

The kids were quite good during the baseline. I remember saying to Hanne that it would be better if they "acted up" more now so we could have it in the data. I remember thinking that the kids would never sit still long enough to have their blood pressure and pulse taken. Of course, I was astonished, as I think we all were at how quickly they accepted it. Two of the boys (1 and 6) enjoyed it and would roll up their sleeves in anticipation.

The routine was soon established and most of the kids looked forward to Hanne's coming.

The only other thing I remember is feeling offended on the kids account for being referred to as "hysterical" in the newspaper article.

Chris (Phase II)

At first sight of our newly painted room, I felt almost overwhelmed by the "blueness" and the brightness". (After the lights were adjusted, the room was much more comfortable). At best, on that first day,

the room was slightly distracting. I remember every once in a while, Sue and I would look at each other and shake our heads. I remember that almost everyone else who came to see our room felt the same way. A common comment was "Wow, is it ever blue in here!"

I was surprised at the kids initial reaction. I thought that one student in particular (6) would either get upset or not notice. He did neither but seemed curious and pleased with the change. He kept going to the walls and tapping them. Another lad (1) seemed to really like the new colour. At first, he ran around the room giggling and scratching the walls. Later, when seated, he kept standing up and pointing. We couldn't keep him out of the classroom! When it was time to go out to the central play area, he wouldn't want to leave; once out, he would hang around our classroom door trying to get back in! One of the blind students (4), kept making his way over to the walls to scratch and sniff at the fresh paint.

The kids seemed to enjoy the airy open feel to the room. One child (7) especially, made use of the uncluttered area and would run, screech and somersault across the rug. The kids seemed more attentive and were sitting for longer periods of time. Instead of not finishing our project as before, we continually ran out of things to do.

Other people noticed changes in our kids too. Two very active boys (1 and 6) were not leaving the central play area as much. Other teachers noted a calmness in our students. One said that during the time the room was blue a student (1) who often went into her room during the day, didn't appear there once.

Contrary to my initial feelings that I would never be able to stand the colour, I got used to the room fairly quickly and actually began to enjoy it. I noticed a sharp contrast between our room and the central play

area in terms of colour and light . After spending any amount of time in the blue room, entering the orange central play area is hard on the eyes. Chris (Phase III)

Despite my original skepticism, it appears that, since the room is now back to the original the activity level and the aggressions have been rising. I have noticed a change in one student (1) in particular.

The room seems smaller now; the kids don't seem to make use of the space on the rug as they did in Phase II.

As for myself, I can't honestly say that I felt more relaxed in Phase II. The kids were better so I'm sure that that had an effect on me, but now that the room is back to Phase I, I don't feel consciously any more relaxed or not relaxed than before.

Sue

I very much enjoy working in room 2. Each child is very different, yet each is fun and exciting to work with.

Our room is a very active room. The activity level is often hectic and sometimes exhausting. I find I really need my lunch time and a good hour after school to unwind and relax. The children in the room seem to become more active as the day goes on and I get progressively more "hyper" as well. For this reason my first partner and I had planned our schedule so that our mornings were more structured and we covered our important activities before lunch. Our afternoons usually consisted of only one short activity at the most.

When the Program Supervisor first discussed the idea of a "colour experiment" involving room 2 I admit it sounded interesting. My first thought was, "Well, it might work someplace else, but it won't work with these kids". But I figured no harm could be done by trying and if it worked - all the better!

PART 3

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

This study set out to measure the impact of a colour and lighting change behaviourally and physiologically on severely handicapped children in their school setting. Of the four behaviours considered, aggressive behaviour, easily defined and scored, appears the most changed. Of the physiological measures, the diastolic blood pressure was taken as the best indicator of stress or relaxation. The subjects had their lowest and most stable readings during Phase II, the colour/light test phase of the study.

The positive effects carried on into Phase III, but a gradual increase could be seen with the return to baseline conditions.

These results, indicating a measurable and significant effect of the environmental intervention, are particularly of interest given the limited hours of exposure of the subjects to the test conditions.

Another interesting phenomenon was the observation that blind subjects were as affected as sighted subjects. This observation (and also Pellegrini's work with a colourblind person) gives rise to the hypothesis that, although a person might lack the rods in the eye to differentiate colours or to "see" colours, people do have neurotransmitters in the eye which pick up information from the visible energy source (wavelength) and transmit that information to the brain's hypothalamus, pineal and pituitary glands - effecting the endocrine system.

Support for this theory appeared in the July, 1980 Proceedings of the National Academy of Sciences, by Martino et al. They reported that a hypothalamic hormone, thyrotropin - releasing hormone (TRH, thyroliberin)

appears to be involved in vision, perhaps as a neurotransmitter. Previous research on TRH has shown that it is involved in mood elevation, inhibition of electrical activity of some brain neurons, enhancement of cerebral noradrenaline turnover, potentiation of the exitatory action of acetyloholine, and potentiation of behaviour exitation. However, a great deal of further research along these lines will have to be done in the future.

Although the physiological measurements showed no significant change for the teaching staff, they both reported an improvement in their students and found that helpful for themselves and for classroom management.

The brief October follow up with students, now all in changed settings, is of interest as well. If systolic blood pressure can be taken as a proxy indicator for stress, then what the readings appear to say is that stress is multi-factored and that there are numerous effective ways to intervene environmentally.

Recommendations

It is recommended that colour and lighting selection be given careful consideration in classroom design.

It is recommended that future research be undertaken to separate colour and light in order to determine the impact of each.

In any future study, similar to this one, the following should be considered: longer phases (many advantages, especially via Hawthorne effect), longer daily exposure of the subjects to the test conditions, tighter methodology.

It is recommended that environmental intervention receive serious consideration as a way to intervene in behavioural disturbance in the classroom, and as a means of enhancing classroom functioning.

Future research on stress factors in the classroom for teaching staff is recommended.

Use of interior design expertise is recommended with respect to perceptual considerations in classroom design.

APPENDIX I

Intra-Interobserver Reliability Checks

		Inter	Intra	
Phase I		Observer 2	Observer 1	Observer 1
March 16, p.m.	Aggression 1	6	7	7
	Destruction 2	0	0	0
	Selfabuse 3	4	5	7
April 6, a.m.	Selfabuse 3	8	8	8
		18	20	22
Phase II				
April 13, a.m.	Aggression 1		3	3
(taken two weeks apart)	Destruction 2		3	3
	Selfabuse 3		5	5
	Nonattentive 4		3	3
			14	14
Phase III				
May 11, p.m.	Aggression 1	3	4	
	Nonattentive 4	5	4	
		8	8	

APPENDIX II

Comments by N.P. Gantly, RIDIA, IDC., of Gantly Design International Ltd. Design and Space Planning Consultants:

The paint and carpet modification brought about changes to and decreased, or eliminated, the level of perceptually aggressive objects and visual clutter, i.e. the arrow in the carpet, the angular shape of the space with the many corners, the sharp shapes of the window and door frames. The latter although improved by a change to deep blue from black would have been much better had they been painted out or light blue to match the adjacent wall. The paint modification eliminated the visual clutter from objects on the wall and from the variety of colours - the many objects stuck to the wall were not replaced on the new paint. Since in my opinion, the unconscious rejection of unwanted visual stimuli, of such clutter or visual noise, causes stress, its elimination should not have occurred simutaneously with the colour change causing one to wonder how great an influence it was on the readings.

While on the staff of the University of Alberta and a member of the committee to set guidelines for classroom design, it was my observation that classrooms - particularily at the elementary school level - are the worst areas of applied visual noise. Nothing, colour included, should distract from the task requiring attention and impede unwanted on the visual field.....were they attracted by the smell of the new paint, carpet and the novelty of newness. These factors must not be discounted.

APPENDIX III

PHASE I

Tape #		TIME	RATER	BEHAVIOR FREQUENCIES BEHAVIOR CATEGORIES* 1	2	3	4	:	/	n
1	March 16	P.M.		7	0	7	48		/	6
1	March 17	A.M.		10	1	6	21		/	7
		P.M.		6	1	0	18		/	7
2	March 20	A.M.		4	4	6	35		/	7
3		P.M.		11	0	0	30		/	7
3	March 23	A.M.		1	2	10	28		/	7
		P.M.		7	2	12	54		/	7
2	March 19	A.M.		2	2	1	31		/	7
				48	12	42	265		/	
		Total Mean		12	3	10.5	66.2		/	
		A.M. Mean		4.25	2.25	5.75	28.75		/	
		P.M. Mean		7.75	0.75	4.75	37.5		/	
									/	
									/	

*One column for each behavior category counted

1 - AGGRESSIVE

2 - DESTRUCTIVE

3 - SELF ABUSE

4 - NON ATTENTIVE

n - NUMBER OF STUDENTS

APPENDIX III

PHASE II

Tape #		TIME	RATER	BEHAVIOR FREQUENCIES BEHAVIOR CATEGORIES* 1	2	3	4	:	/	n
6	April 6	A.M.	1 + 2	2	2	8	13		/	7
		P.M.	1	2	1	3	15		/	7
7	April 8	A.M.	1	1	0	3	14		/	7
		P.M.	1	4	1	7	16		/	7
8	April 13	A.M.	1	3	3	5	3		/	7
		P.M.	1	10	0	4	8		/	7
10	April 21	A.M.	1	2	4	3	4		/	7
		P.M.	1	0	1	0	6		/	7
				24	12	33	79		/	
		Total Mean		6	3	8.2	19.7		/	
									/	
		A.M. Mean		2	2.25	4.75	8.5		/	
		P.M. Mean		4	0.75	3.5	11.2		/	
									/	
									/	

*One column for each behavior category counted

1 - AGGRESSIVE

2 - DESTRUCTIVE

3 - SELF ABUSE

4 - NON ATTENTIVE

n - NUMBER OF STUDENTS

APPENDIX III

PHASE III

Tape #		TIME	RATER	BEHAVIOR FREQUENCIES BEHAVIOR CATEGORIES* 1	2	3	4		//	n
12	April 28	A.M.		3	4	2	7		//	7
		P.M.		8	0	6	7		//	7
14	May 12	A.M.		2	1	4	5		//	7
		P.M.		4	0	3	6		//	7
15	May 14	A.M.		3	5	1	4		//	7
		P.M.		5	0	2	8		//	7
15	May 15	A.M.		1	0	0	4		//	7
		P.M.		4	0	0	6		//	7
				30	10	18	47		//	
		Total Mean		7.5	2.5	4.5	11.75		//	
									//	
		A.M. Mean		2.25	2.5	1.75	5.0		//	
		P.M. Mean		5.25	0.0	2.75	6.75		//	
									//	
									//	

*One column for each behavior category counted

1 - AGGRESSIVE

2 - DESTRUCTIVE

3 - SELF ABUSE

4 - NON ATTENTIVE

n - NUMBER OF STUDENTS

APPENDIX IV

STANDARD DEVIATIONS

Physiological Measurements - Systolic and Dyastolic Blood Pressure and Pulse

Variances	N	Syst.	Diast.	Pulse
Last Day Ph.I	27	6.98	6.50	11.81
Ph.II	27	8.66^2	7.38^2	7.82^2
Ph.III	26	11.01	8.41	8.32

Given S_2^2 S_1^2

$$F = \frac{S_2^2}{S_1^2}$$

Compare against a Table Value of F for N_2-1 and N_1-1 degrees of freedom

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Bartletts Test

I - II NSD F = 1.54

II - III NSD F = 1.62

These standard deviations are showing a normal pattern with some significance.

APPENDIX IV Contd.

The ratio of 15.76 supports the conclusion that the variable which is measured, is different across Phases. The computer plots for Diastolic blood pressure and pulse, show similar graph perfomances as the Diastolic blood pressure graphs although in a much less pronounced manner. Pulse readings again are not always reliable. Therefore, the main significance lies in the Diastolic blood pressure plots and graphs.

There were 10 days in Phase I, 13 days in Phase II and 14 days in Phase III. In the analysis, in order to even the sample, 3 days were dropped from Phase II and 4 days from Phase III.

The differential between the Phases is statistically significant.

REPEATED MEASURES ANALYSIS OF DIASTOLIC BP

ANALYSIS OF VARIANCE FOR 1-ST
DEPENDENT VARIABLE - X(1) X(2) X(3) X(4) X(5) X(6) X(7) X(8) X(9)
X(10) X(11) X(12) X(13) X(14) X(15) X(16) X(17) X(18)
X(19) X(20) X(21) X(22) X(23) X(24) X(25) X(26) X(27)
X(28) X(29) X(30) X(31) X(32) X(33) X(37) X(38) X(39)
X(40) X(41) X(42) X(43) X(44) X(45) X(46) X(47) X(48)
X(52) X(53) X(54) X(55) X(56) X(57) X(58) X(59) X(60)
X(61) X(62) X(63) X(67) X(68) X(69) X(70) X(71) X(72)
X(76) X(77) X(78) X(79) X(80) X(81) X(82) X(83) X(84)
X(88) X(89) X(90) X(91) X(92) X(93) X(97) X(98) X(99)
X(100) X(101) X(102) X(103) X(104) X(105) X(109) X(110) X(111)

	SOURCE	SUM OF SQUARES	DEGREES OF FREEDOM	MEAN SQUARE	F	TAIL PROBABILITY
	MEAN	1660935.38000	1	1660935.38000	2580.75	0.0000
1	ERROR	2574.34222	4	643.58556		
	PHS	1831.96000	2	915.98000	15.76	0.0017
2	ERROR	464.81778	8	58.10222		
	DAY	14681.44222	9	1631.27136	5.08	0.0002
3	ERROR	11564.05778	36	321.22383		
	PD	28395.68444	18	1577.53802	4.39	0.0000
4	ERROR	25874.64889	72	359.37012		
	TIM	5205.85333	2	2602.92667	16.66	0.0014
5	ERROR	1249.59111	8	156.19889		
	PT	1091.50667	4	272.87667	2.67	0.0702
6	ERROR	1634.04889	16	102.12806		
	DT	8146.32444	18	452.57358	3.89	0.0000
7	ERROR	8370.00889	72	116.25012		
	PDT	26564.84889	36	737.91247	7.84	0.0000
8	ERROR	13546.48444	144	94.07281		

APPENDIX IV

REPEATED MEASURES ANALYSIS OF SYSTOLIC BP

ANALYSIS OF VARIANCE FOR 1-ST
DEPENDENT VARIABLE - X(1) X(2) X(3) X(4) X(5) X(6) X(7) X(8) X(9)
X(10) X(11) X(12) X(13) X(14) X(15) X(16) X(17) X(18)
X(19) X(20) X(21) X(22) X(23) X(24) X(25) X(26) X(27)
X(28) X(29) X(30) X(31) X(32) X(33) X(37) X(38) X(39)
X(40) X(41) X(42) X(43) X(44) X(45) X(46) X(47) X(48)
X(52) X(53) X(54) X(55) X(56) X(57) X(58) X(59) X(60)
X(61) X(62) X(63) X(67) X(68) X(69) X(70) X(71) X(72)
X(76) X(77) X(78) X(79) X(80) X(81) X(82) X(83) X(84)
X(88) X(89) X(90) X(91) X(92) X(93) X(97) X(98) X(99)
X(100) X(101) X(102) X(103) X(104) X(105) X(109) X(110) X(111)

	SOURCE	SUM OF SQUARES	DEGREES OF FREEDOM	MEAN SQUARE	F	TAIL PROBABILITY
	MEAN	4392055.22000	1	4392055.22000	4487.37	0.0000
1	ERROR	3915.03556	4	978.75889		
	PHS	53972.21333	2	26986.10667	95.60	0.0000
2	ERROR	2258.16444	8	282.27056		
	DAY	31180.89111	9	3464.54346	4.70	0.0004
3	ERROR	26531.63111	36	736.98975		
	PD	63813.20889	18	3545.17827	4.05	0.0000
4	ERROR	63049.96889	72	875.69401		
	TIM	13904.25333	2	6952.12667	23.28	0.0005
5	ERROR	2388.59111	8	298.57389		
	PT	1639.09333	4	409.77333	2.15	0.1211
6	ERROR	3044.12889	16	190.25806		
	DT	28470.76889	18	1581.70938	8.03	0.0000
7	ERROR	14181.27556	72	196.96216		
	PDT	75326.15111	36	2092.39309	10.78	0.0000
8	ERROR	27962.40444	144	194.18336		

APPENDIX IV

REPEATED MEASURES ANALYSIS OF PULSE

ANALYSIS OF VARIANCE FOR 1-ST
DEPENDENT VARIABLE - X(1) X(2) X(3) X(4) X(5) X(6) X(7) X(8) X(9)
X(10) X(11) X(12) X(13) X(14) X(15) X(16) X(17) X(18)
X(19) X(20) X(21) X(22) X(23) X(24) X(25) X(26) X(27)
X(28) X(29) X(30) X(31) X(32) X(33) X(37) X(38) X(39)
X(40) X(41) X(42) X(43) X(44) X(45) X(46) X(47) X(48)
X(52) X(53) X(54) X(55) X(56) X(57) X(58) X(59) X(60)
X(61) X(62) X(63) X(67) X(68) X(69) X(70) X(71) X(72)
X(76) X(77) X(78) X(79) X(80) X(81) X(82) X(83) X(84)
X(88) X(89) X(90) X(91) X(92) X(93) X(97) X(98) X(99)
X(100) X(101) X(102) X(103) X(104) X(105) X(109) X(110) X(111)

	SOURCE	SUM OF SQUARES	DEGREES OF FREEDOM	MEAN SQUARE	F	TAIL PROBABILITY
	MEAN	3232237.87556	1	3232237.87556	15367.78	0.0000
1	ERROR	841.30222	4	210.32556		
	PHS	27705.65778	2	13852.82889	32.39	0.0001
2	ERROR	3421.76444	8	427.72056		
	DAY	24720.96889	9	2746.77432	4.44	0.0006
3	ERROR	22289.85333	36	619.16259		
	PD	69892.16444	18	3882.89802	5.22	0.0000
4	ERROR	53524.41333	72	743.39463		
	TIM	9774.73778	2	4887.36889	40.55	0.0001
5	ERROR	964.28444	8	120.53556		
	PT	2365.36889	4	591.34222	5.17	0.0072
6	ERROR	1831.60889	16	114.47556		
	DT	24249.08444	18	1347.17136	10.19	0.0000
7	ERROR	9522.56000	72	132.25778		
	PDT	71343.34222	36	1981.75951	19.28	0.0000
8	ERROR	14801.01333	144	102.78481		

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